November 4, 1999

Impulse Response Measurements, January 1995
Complex Impulse Response Data Structure

The processed complex impulse data is contained in binary files that are named 00000xxx.sep where xxx is the file number from 001 to 999. Each binary processed data file consists of a file header and one or more records. Each record represents a sequence of data acquisitions and has its own header. A sequence of data acquisitions can be 1 to 128 acquisitions captured sequentially, spaced a specific time interval apart, and represent a data segment within each record.

Header information consists of various data types which can be accessed by knowing byte location within the particular header. The various data types are described by the following:

integer:	2 byte signed integer
unsigned integer:	2 byte unsigned integer
float:	4 byte IEEE floating point value
double:	8 byte IEEE floating point value
string:	character string with the number of characters described in the following explanations. Each character is one byte long. Each string is terminated with a null character (\0).

The file header contains 14 elements, with at total size of 500 bytes, and consists of the following:

byte location	description	data type	size (bytes)
<0>	Cell Number	integer	2
<2>	Cell Description	string	126
<128>	Route Number	integer	2
<130>	Record Size Factor	unsign int	2
<132>	Segments	integer	2
<134>	Delay Between Segments	float	4
<138>	Number of Records	integer	2
<140>	Sample Rate (in Hz)	double	8
<148>	Antenna Height	float	4
<152>	Antenna Polarization	integer	2
<154>	Antenna Type	string	126
<280>	Comments	string	126
<406>	Date	string	10
<416>	Reserved space	string	84
<500>	Start of 1st Record		

Byte location describes the number of bytes into the header for which the particular element is located.

Record Size Factor can be used to determine the size in bytes of each record (including the header) according to the following formula:

Record Length (in bytes) = ((Record Size factor) * 8176) + 150

Segments gives the number of segments for a sequential acquisition. Delay between segments gives the number of seconds between acquisition of each segment within a sequential acquisition. (This delay is defined as the time between the start of one acquisition and the start of the next sequential acquisition). Number of Records gives the total number of data records located within the file. Each data record consists of 1 to 128 segemets, each containing 4088 2-byte integer values. The first 2044 values refer the magnitude of the impulse response in dB. The second 2044 values refer to the phase of the impulse response in degrees. Sample rate is the data acquisition rate given in units of Hz. Antenna Height refers to the receiving antenna and is measured in meters. Antenna polarization is an integer which associates with one of the following polarizations:

1 -- Horizontal Polarization
2 -- Vertical Polarization
3 -- Slant Polarization
4 -- Right Circular Polarization
5 -- Left Circular Polarization

Antenna Type is used to describe other specifics of the antenna (example: omni directional). Date gives the date of the acquisition and is represented in the following format 00/00/00 (month/day/yr).

The record header is located at the beginning of each data record. It has 9 elements, with a total size of 150 bytes, and consists of the following:

byte location	description	data type	size (bytes)
<0>	Code Type	integer	2
<2>	Carrier Frequency	double	8
<10>	SA Attenuation	integer	2
<12>	Magnitude Scaler	float	4
<16>	Phase Scaler	float	4
<20>	GPS Coordinates / Time	string	50
<70>	Speed	string	50
<120>	Time	string	14
<130>	Reserved	string	16
<150>	Start of data		

Byte location describes the number of bytes into the header for which the particular element is located.

Code Type refers to one of two types of PN codes used. The transmitted BPSK signal is generated by modulating a CW signal with a single 511 bit PN code sequence. Carrier Frequency gives the frequency in Hz of the signal carrier frequency. SA Attenuation is the attenuation in dB of the spectrum analyzer used to down-convert the specific signal. Magnitude Scaler and Phase Scaler are used to convert the data integer value to the original floating point value. Therefore, each data point must be scaled in the following manner:

Magnitude of Impulse response = Data * (Magnitude Scaler).

Phase of Impulse response = Data * (Phase Scaler).

GPS Coordinates/Time & Speed are strings containing the Trimble ASCII Interface Protocol (TAIP) output from the Trimble Navigation Placer GPS/DR receiver and has the following format:

>RPVAAAAABBBCCCCCDDDDEEEEEFFFGGGHI<

Field	Significance
A	UTC of fix (seconds)
B.C	Latitude (in degrees, with decimal minutes: + = N, - = S)
D.E	Longitude (in degrees, with decimal minutes: - = W, + = E)
F	Speed (MPH)
G	Heading (0 = N)
H	Source (0=2D GPS, 1=3D GPS, 2=2D DGPS, 3=3D DGPS, 6=DR, 8=Degraded DR, 9=?)
I	Age of Indicator (2=Fresh, <10 sec; 1=Old, >10 sec; 0=Not available)

If a particular field is not determined, only >RPV< would appear. The "GPS Coordinates/Time" string and the "Speed" string are identical.

The record header element, Time, is obtained by reading the computer clock. The format of this string is as follows: 00:00:00.000 (hr:min:sec.fraction). Note that the seconds have a fractional component with 3 significant figures to the left of the decimal point.

The overall structure of the data file is as follows:

FILE HEADER, RECORD HEADER, DATA, RECORD HEADER, DATA, ...

The data is stored as 16 bit signed integers (two bytes) and the size of the each data section is dependant on the number of segments captured with each data acquisition. The structure of each data section is as follows:

MAGNITUDE (SEGMENT #1), PHASE (SEGMENT #1), MAGNITUDE (SEGMENT #2), PHASE (SEGMENT #2), MAGNITUDE (SEGMENT #3), PHASE (SEGMENT #3)...

The number of segments is dependant on the number of sequential acquisitions. (i.e. if there are 128 sequential acquisitions with each record, then there are 128 segments.)

To determine the byte location for the first data point of the MAGNITUDE or PHASE data for a specific segment within a specific record, use the following formula:

byte # = 650 + ((r-1)*((segs*8176)+150)) + 150 + ((s-1)*8176) + (p*4088)

where:

segs = number of segments captured with each sequential acquisition
r = record number within the data file 1, 2, 3, ...
s = the segment number within the record 1, 2, 3, ...
p = 0 for magnitude data and 1 for phase data

To determine the byte location for the header associated with a specific record, use the following formula:

byte # = 500 + ((r-1)*((segs*8176)+150))

where:
segs = number of segments captured with each sequential acquisition
r = record number within the data file 1, 2, 3, ...